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Description of an Invention

FOR

REMOVING OR DESTROYING THE MOMENTUM;

OR

OVERCOMING THE INERTIA, OF HEAVY BODIES,

BY

WILLIAM GRAHAM McIVOR, C.M.R.B.S.E.,

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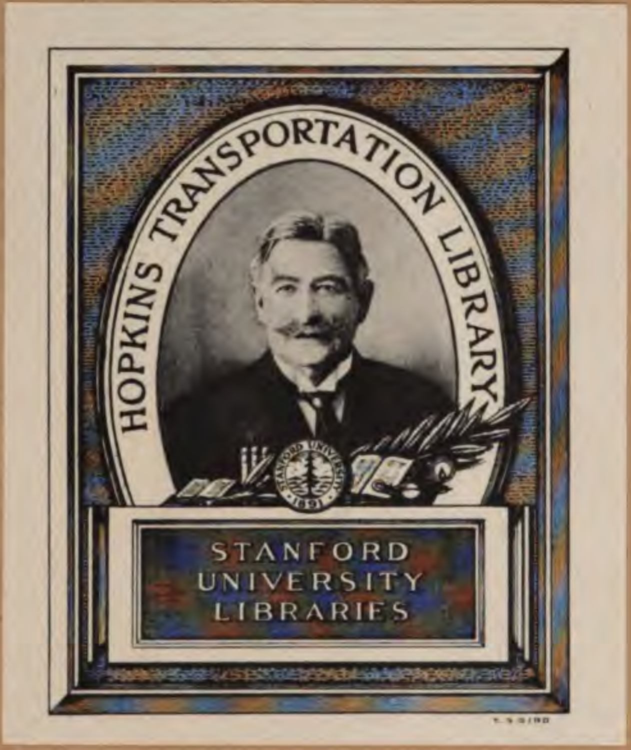

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OVERCOMING THE INERTIA, OF HEAVY BODIES,

BY

WILLIAM GRAHAM McIVOR, C.M.R.B.S.E.,
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DESCRIPTION OF AN INVENTION FOR REMOVING OR DESTROYING THE MOMENTUM OF HEAVY BODIES, BY MEANS OF AN ELASTIC MACHINE OR MACHINES, SO AS TO PREVENT INJURY AND DAMAGE FROM CONCUSSION. APPLICABLE TO SHIP CABLES, SHIP AND FORT ARMOUR, RAILWAY TRAINS, FENDERS TO PIER HEADS AND FLOATING PIERS, GANGWAYS, BREAKWATERS, AND OTHER SIMILAR STRUCTURES, ALSO AS A MOTIVE POWER.

1. This Pamphlet giving a brief outline of the above invention, which it is hoped may ultimately prove the means of increasing the safety, and reducing the cost of transport of goods and passengers by sea and land, is written for private circulation, and with a view to solicit information of such objections as the reader may see to the practical application of the method proposed. It is with much diffidence that the author submits his opinions on so important a subject, especially as it is one in which he has not had the advantage of special training. He consequently feels that schemes however perfect they appear in his mind, may prove altogether useless from the practical difficulties of application. It will be seen that the author has contemplated and solved many of these difficulties, and such as have not occurred to him, serious as they may appear at first sight, when once fairly ascertained, ought to be overcome. With this object the author appeals to all who are conversant with the subject for their aid and assistance in developing an invention, which, when successfully applied will be fraught with results of the utmost importance. The invention consists in the adaptation and arrangement of circular or coiled springs secured to an axle and supported on a frame, or framework, constructed of any convenient and suitable material; or by enclosing the springs in a drum or cylinder so as to procure and apply their elastic force both by the cylinder and axle. The first subject to which the author proposes to apply his invention is that of Ship cables.

2. In Mechanics it is a well known law that an accumulated force, *i. e.*, a body having once gained a momentum, such for instance as a Railway Train, Ship, or wave of the sea, can only be prevented from causing concussion and damage when coming in contact with another body, by, the body struck, (or both bodies when practicable) presenting an elastic and accumulating resistance, as every line of space through which the elastic body recedes, destroys a portion of the momentum of the aggressive body, until it is altogether overcome and consequently no injury sustained. The utility of an elastic action in Ship cables, has been long appreciated and hitherto sought for in some elastic material for their manufacture. The pre-

sent invention is intended to secure this elastic action by connecting the cables to an elastic bearing attached to the vessel. This would enable Ships while at anchor, to ride out the most severe Cyclones, storms and gales, without danger to the Ship itself, without drag to the anchors, and without strain to the cables. While when used as a windlass, the elastic action of the springs will greatly facilitate the operation of heaving the anchor.

3. To illustrate the advantage of this invention when applied to Ship cables, it becomes necessary to compare it with what has already been done in order to secure elasticity. The coir cable is the most effectual mode hitherto adopted, and although this possesses advantages, and has been the means of saving many vessels, still in some respects it is practically ineffectual, inasmuch as its elastic tendency does not act with sufficient rapidity to intermit with each wave, and in extremely strong and continuous gales, the vessel at last labors as heavily as under a cable of chain or of hemp, in consequence of the elasticity of the coir fibre being destroyed by the strain.

4. The chain cable gives a certain amount of elasticity by its describing a catenary curve, which in heavy weather becomes strained to nearly a straight line thereby permitting the vessel to retire. This curve, however, affords no elastic yielding to the momentum of the waves, as a wave striking the Ship with a force sufficient to knock her to pieces, would not cause the cable to rise instantly through the superincumbent weight of water. Although in an ordinary gale the curve has some advantage, yet in a heavy storm the chain assuming nearly a straight line, its action to stress of weather becomes lost at the very moment when the preservation of the Ship requires that it should be most active. What is required in Ship cables, is an elastic agent which shall act and re-act permitting the vessel to advance and recede with each wave. Apart from these considerations, all cables as they are now fixed to the vessel possess the serious disadvantage of dragging the bows of the Ship downwards with a force proportionate to the combined force of the wind and waves upon the Ship herself, that is, the cable drags the vessel to the bottom of the sea (to a plane with the anchor or point of attachment) with a force proportionate to that with which the storm drives her in a horizontal direction. This downward drag of the cable has also the effect of forcing the bows of the vessel to plunge deeply, thus placing her in the worst position to weather a storm, causing her to ship the seas, and receive the full force of each wave which otherwise she would have ridden over.

5. The present invention will overcome the above defects. The elasticity of the bearing being effectual, while its action is instantaneous, and on a plane with the force to be resisted, the Ship as it meets the seas is enabled to ride over them, and to recede at the same time; the action of the springs prevent her head from being dragged down, and maintain her bows in a direct line to the storm, however rapidly the direction of the winds and seas may change.

6. In applying this invention, the size and stability of the frame, or framework, and cylinder, the strength, length, breadth, and number of springs used in the machine being regulated by, and proportioned to, the weight and force it is intended to resist or overcome;

and in such as are intended to give elastic bearings to Ship's cables, the strength may be double that of the calculated strain to which the machine is likely to be subjected.

7. The elastic bearing may be applied to Ship's cables in different ways. The three following modes of application are selected for description :—First, by a messenger, or by the cables being wound round the circumference of a drum or cylinder revolving on a *fixed* axle :—Secondly, by the messenger or cable being fixed on, or passed round a flanged or other wheel, secured to a *revolving* axle ; the springs being attached to a fixed cylinder, or framework :—Thirdly, by both the axle and cylinder being constructed to revolve, either of them being fixed at pleasure by Pauls acting on the Ratchets hereafter described ; by this arrangement the machine can most effectually perform the work of the capstan and windlass.

8. The machine illustrated in Plate No. I, is that of a cylinder or drum (revolving on an axle *fixed* by Pauls and Ratchets,) containing a number of coiled springs, secured at one end to the axle, and at the other end to the cylinder. These springs exert their force against the cables, or cable stoppers, which are fixed on, or wound round the cylinder, therefore as the cable is dragged forward over the bows by the force of the sea and wind, causing the Ship to recede, the cylinder revolves giving out cable and winds up the springs on the fixed axle ; as the force of the wave passes, the springs react, or unwind, bringing back the cable, or cable stopper, thus producing a perfect elastic bearing of great simplicity and enormous strength.

9. In the above Drawing, Figures I to IX inclusive, illustrate on a scale of one inch to the foot the construction of a machine or apparatus of size and strength intended for a vessel of between 1,000 or 1,500 tons burthen. Figure I being a longitudinal section shewing the principle of construction when required to act as a cable stopper, windlass, capstan or other purposes to which it may be applied. A, being 12-coiled steel springs secured to the axle and starting from its alternate angles, the outer ends of the springs being fixed to the opposite bars of the cylinder. By this arrangement the lateral pressure of the one spring on the axle counteracts the other, and gives a uniform support to the cylinder by the fastenings shewn at O. B, being the end of the axle. C, rounded portion of the axle to revolve in the frame. D, rounded portion of thé axle to revolve in the end of the cylinder. E, Hand-spike and Ratchet wheel. F, cog wheel. G, Pauls acting on the ratchet wheel E. H, Pauls to act on the ratchet on the ends of the cylinder when used as a motive power. I, the key for securing the ratchet and cog wheel to the end of the axle. J, the longitudinal bars for fastening the springs to the inner circumference of the cylinder. K, Rivets, fastening the bars to the cylinder. L, screws and nuts securing the bars J to the ends of the cylinder. M, lubricating holes. N, the framework. O, fastenings of the outer ends of the springs to the bars.

10. Figure II. Section of a portion of a cylinder constructed with whelps for fleeting the cable. A, the coiled springs. B, the ends of the axle for the reception of the ratchet and cog wheel. C, depression in the axle for keying on the ratchet and cog wheel. D, the whelps. M, the lubricating holes.

11. Figure III. Section shewing the fitting of the cable when applied in a grooved wheel secured on the revolving axle. A, the axle. B, the key. C, the guide roller with depressions for the reception of the alternate or projecting links of the cable. D, grooved wheel with corresponding depressions, so that the alternate links may pass between the wheel and roller.

12. Figure IV. View of the cylinder with chain cable, and cable stopper. A, the chain cable stopper. B, the cable working over the guide roller C, which is placed sufficiently distant from the cylinder to allow the cable links to pass flatwise between them ; the projecting links passing in the indentations in the cylinder and roller as at D. E, the ratchet wheel. F, the cog wheel. G, the Pauls. H, the framework. I, the end of the cylinder with handspike holes and ratchet. J, Pauls to act on the same. View of a portion of the axle to revolve in its bearings and ends of the cylinder. J, rounded portion. K, octagonal (or square) portion for the reception of the springs. M, lubricating holes. Figure V. A, hook and grip for securing the cable stoppers to the cables. B, the back view of the same.

13. In Figure VI the solid lines illustrate the cross section of the cylinder with the springs unwound on the axle, and to give their elastic force by winding up ; but, this may be modified by constructing the springs to be closely coiled around the axle when in a neutral condition, and to give their elastic force in unwinding against the cylinder. D, being the axle. E, the four cross bars to which the springs are secured alternately. When two cables are placed on the same cylinder, it may be necessary that the one be stationary while the other is in action. To effect this, a circle or ring of wrought or cast iron or any other suitable material, to receive the cable, may be fitted over and revolve on the cylinder, to be secured when necessary to the cylinder by gripping screws, wedges, keys, or spring-catches. The dotted lines illustrate this circle, with a lever to support its weight in order to prevent friction when the cylinder is revolving and the ring or circle stationary. F, being the keys for securing the ring or circle at A, when brought into action. B, spring-catches. C, the lever. The spring-catches being constructed as shewn at G, with dentations for the reception of the projecting cable links.

14. Figure VII. The end view of the cylinder fixed in its position on the framework. A, the ratchet and cog wheel. B, pinion wheel. C, winch-handle attached to the axle of the pinion wheel. D, end of the axle. E, Pauls. The pinion wheel is introduced to give a fast or slow motion to the cylinder or windlass.

15. Figure VIII. End of cylinder, shewing the manner in which it is cast and secured by screws and bolts. B, screws and nuts on the ends of the bars. A, lubricating holes.

16. Figure IX. Two rollers for the hawse holes. A, rollers. B, planking of the Ship. C, door for closing the hawse holes when not in use.

17. Figure X, is a sketch of the cylinder when applied as a capstan. A, the cylinder containing the springs. B, the axle. C, the whelps. D, the partners. E, the Pauls. F, the Paul rim. The portion on which the whelps are attached, being securely fastened to the

axle, the hand-spikes being applied to cause the cylinder to revolve, the force is communicated to the axle by the springs, and thus act on the cable or messenger. The cylinders here illustrated being joined at the neck between the partners.

18. Figure XI, is a sketch of the forepart of a Ship with the cylinder fixed in position. A, the cable. B, the cylinder. C, projecting sockets for the reception of the hawse hole rollers constructed so as to allow of the rollers being removed and the hawse holes closed when the Ship is at sea.

19. Figure XII, is a sectional sketch illustrating the working of the cable, when the cylinder is used as a windlass (or when placed in a perpendicular position as a capstan) this arrangement is intended to overcome the inconvenience of stoppering and fleeting the cable. As the cylinder A revolves the guide roller B, working a belt or chain passing over the sprocket wheel or roller C, both B and C being of the same diameter, removes from or deposits in the cable locker E, the same length of chain as is given out or taken up by the cylinder. The position of the locker may be placed further aft than illustrated; and the walls of the chain well D, padded to prevent noise from the movement of the cable, while the weight of the cable suspended in the well D, and passing over the roller B, acts by a leverage on the cylinder, and considerably relieves the springs. In some instances it may be desirable to direct the cable on to the guide roller B by rollers similar to those illustrated for the hawse holes.

20. The benefit of elasticity when applied to Ship cables, is so well understood and appreciated as scarcely to require notice. This invention, however, possesses special advantages in its application :—1st, its action being instantaneous and on a plane with the force to be resisted, the Ship as it meets the seas is enabled to rise over them, and recede at the same time, regaining her position in the interval of each wave. 2nd.—Perfect elasticity of the cable bearing. 3rd.—The elastic play may extend from 200 to 900 feet and upwards. 4th.—The elastic force may be increased to any required degree by winding up the springs more or less against the cable or cable stoppers by the hand-spike wheel illustrated at E in Figure IV, or by the pinion wheel B in Figure VII; for example, a cylinder giving 90 revolutions, its force against the cable or cable stoppers can be increased as 90 to 1, as the force of the springs increases or decreases in nearly this ratio with every revolution in winding up, or unwinding. 5th.—The springs would occupy but little space, and being enclosed in a waterproof cylinder would be preserved from rust, and consequently be very durable. 6th.—It places the Ship under immediate control, enabling her position to be changed with facility, either by the cable being given out, or heaved up by the cylinder.

21. The anchor is raised or weighed by the action of the cog wheel F in Figure IV, when turned either by the hand-spike wheel E or by the pinion wheel B in Figure VII; when worked by the winch-handle C, thus the springs are wound up on the axle and communicate the force to the cylinder, causing it to revolve and heave in the cable, consequently there exists the elastic play of the springs between the cable and the men, whether using the hand-spike wheel E, Figure IV, or the pinion wheel B, Figure VII, thus securing the chain and cable

against the accidents to which they are at present liable when the Ship is brought up short a Peak in a chopping sea, as the springs will invariably act on any strain. An additional advantage exists in the fact that by the hand-spike or lever a man can give great force by a sudden exertion, and the springs take up and continue to exert this force for any length of time, until the anchor is "neared" or "breaks ground," hence a great saving of labour will be effected in heaving in the cables, which will enable Ships to be worked with fewer hands.

22. The great desideratum with seamen is to give them such an appliance as will bring the anchor to the bows in the shortest possible space of time after it " breaks ground," so as to get the Ship immediately under control. This, the invention thoroughly effects; but, the powerful reaction of the springs might produce damage by bringing up the anchor too suddenly, especially when anchored in shallow water; as a security against this, it will be necessary to check or retard the reaction of the cylinder by the application of a break.

23. By the foregoing remarks, it will be understood, that when the machine is in use as an elastic bearing, the Pauls G, Figure IV, must act on the ratchet wheel, and the Pauls to act on the ends of the cylinder removed. But when the cylinder is used as a motive power for working pumps, heaving cargo, hoisting sails, driving punkahs or to any other purpose, this must be reversed, the Pauls J being inserted on the ratchet on the end of the cylinder, while the Pauls G are removed from the ratchet wheel. The winch-handle C being also removed from the pinion wheel B in Figure VII, and a *driving* wheel placed in its position. In some instances it may be desirable to introduce a Diaphragm between each spring.

24. *Application of the invention to Ship and Fort Armour*. It is important for the protection of Ships that their armour should be supported on some elastic material, so that on a ball striking the plates, all vibration may be removed from the body of the Ship. Although a vessel be plated with armour sufficient to throw off the heaviest balls, it is still far from secure against damage; because the concussion of each ball communicates to the Ship an amount of vibration which starts the bolts, and otherwise damages the walls of the vessel, so that under a heavy battery she would shortly be rendered unserviceable. Therefore it will be evident that the plating should not touch the walls of the Ship; but that the armour plate should be made in lengths sufficient to reach from the upper deck to any desired distance below the water line, the breadth of each plate being about two feet, and supported on a loop joint at the bottom, so that on going into action the whole of the armour plates could be projected forward in an instant, and admit the water between the plating and the walls of the Ship, the stratum of water thus admitted being about four feet thick at the water line. By this arrangement and supporting the upper ends of the plates on a lever projecting from a powerful spring cylinder, all concussion and vibration would be effectually removed from the Ship. This seems to be the only principle upon which armour plating can be effectually applied as a protection to Ships: there is, however, an extreme difficulty in resisting a very heavy ball, say of 500 lbs., travelling at the high velocity of 2,000 to 4,000 feet per second, as the initial force of such a projectile carries it through any impediment before communicating a pressure to the surrounding material. Hence it is evident that effectually to resist such a projectile, the armour plating must present a greater substance, or be thicker by a few

inches than the diameter of the ball, both being of the same cohesive strength. A farther protection might be given to the machinery of vessels by constructing the water tanks in cells and placing them amidships along the inside of the outer walls. This system of water tanks formed in small compartments and constructed to fit the walls of the vessel water-tight, so that on the walls and one or two of the cells being penetrated by balls, the outer water would be unable to pass to the interior of the Ship. These cells filled with water, from 6 to 9 feet broad, would present an impassable barrier to balls; from the fact that water is incompressible and offers a very great resistance to the penetration of a projectile.

25. Serious objections exists to the use of iron or steel for Ship armour:—1st.—Its great weight. 2d.—The defective cohesion of its particles, rendering it liable to crack when struck, which indicates resistance to penetration at a few points only, and this defect becomes more apparent the greater the volicity of the projectile. 3d.—Its power as a conductor of vibration. 4th.—The facility with which it corrodes when in contact with salt water. Wood on the contrary possesses advantages where iron is defective; but unfortunately is penetrated with much greater facility. This defect however is more attributable to the position in which it is at present placed to receive the balls, than to any inherent defectiveness in the wood itself, because the wood of a tree is nothing more than a conglomeration of woody tubes, running perpendicular from the base to the top of the stem. It will therefore be plain that by a lateral blow these tubes are easily penetrated by being forced aside or broken; but deprive these woody tubes of the power of lateral expansion, and strike the beam with the same force on its end, no damage ensues because the tubes are now pressed lengthwise, instead of across their section, hence they offer very great resistance to penetration, while fracture or splinter becomes impossible. The further the projectile penetrates wood in this direction, the more the resistance increases as the ball must carry and compress before it, a certain number of the woody tubes until they become as solid and impenetrable as iron. For this reason, in constructing the walls of a Ship, the ends of the beams only should be exposed in the direction of the shot; these walls being built of beams one foot square or any other convenient size, fitted close, and bound together by horizontal and perpendicular, bands of iron 1 or 2 inches deep, and from 12 to 24 inches wide, introduced between each beam and at a distance of 2 or 3 feet apart along its entire length. The walls of a Ship thus constructed and from 6 to 15 feet in thickness, would offer an impenetrable barrier to any projectile now in use, and probably to any which may be invented; the balls would of course be deposited in these wooden walls, and in order to guard against the effects of red-hot shot, the wood should be rendered incombustible by being impregnated with pearl ash or other suitable material, but even without this impregnation, there would be little danger from red-hot shot from the fact that the fibre of the wood contracting immediately on the passage of the ball and filling up the entrance, would prevent ingress of oxygen to support combustion. Shells thrown into the walls and there exploding would be discharged as from the mouth of a gun, through the hole by which they entered, because all explosive material escapes at the point of least resistance. The termination of these walls would require to be bound with very powerful iron, as also the port-holes; which if made funnel-shaped would perhaps be most convenient. A Ship built as above described must possess great advantages as a sea-going

vessel. She would have great speed, enormous strength, and draw but little water in proportion to her size. She could run down other vessels without injury to herself, and would be safe if even running foul of either rocks or icebergs.

26. Great difficulty being experienced on board-ship in discharging guns at the true horizontal line or at any required elevation, it would appear desirable to fire them by electricity. This could be done by means of a heavy pendulum with semi-circular arms, which would invariably maintain the true perpendicular, and consequently the top of the arms the true horizontal line. The point of the arms coming in contact with a conductor when the Ship is level, would admit at that moment a spark to discharge the guns. By this arrangement an entire broadside could be thrown instantaneously, and with unerring precision upon any one point of the enemy's Ship, and guns worked in this way could be discharged from Ships with equal certainty and greater effect than from land batteries. Under the system hitherto adopted in training guns, it is impossible that a broadside can be instantaneously discharged, on account of the concussion and recoil, which places the Ship in danger. To overcome this, as well as to avoid the great labour, and remove the delay which at present attends training heavy ordnance, it is necessary that the guns should recoil against an elastic cylinder placed on the opposite side of the Ship; the ropes or bands being conducted from the cylinder to the gun in the manner illustrated in Plate No. III, Figs. I and II; the rollers for the ropes or bands being placed near the wall of the Ship above the gun. Thus the drag of the rope or bands on the cylinder by the recoil of the guns would raise the *opposite* side of the Ship and depress that on which the guns were discharged, compensating for the reduction in weight near the side, by the guns recoiling towards the Ship's centre. Also the springs by their reaction would almost instantly throw the guns back to the spot where they are to be re-loaded, or to a convenient distance from the Ship's walls, and immediately restore the equilibrium. By this arrangement it is anticipated that the instantaneous discharge of the whole broadside would not cause the ship to sway more than a few inches; while all concussion and vibration would be removed by the guns recoiling with the utmost freedom against a perfectly elastic bearing.

27. As above mentioned the invention may be applied to both Ship and Fort Armour by means of levers or supports projecting from the axle or circumference of a series of springs or spring cylinders, constructed as before described. The Armour plates being supported by the levers so as to give elastic play to remove concussion and vibration from the walls of the Ship or Fort. When applied to the training of guns the tackle is attached to a spring cylinder so as to bring the recoil of the gun against a perfect elastic bearing. The gun may then be stopped by a catch and re-loaded at a convenient distance from the Embrasure or Port. The catch being removed, the reaction of the springs will run the gun forward, the motion of the cylinder being governed by a break so as to enable the operator to regulate the force of the reaction, and consequently move the gun as may be required. The situation of the cylinders for this purpose should be near the walls of the Fort, and in Ships, either below the gun or upper deck; or, in any other convenient position. The ropes from the gun or gun-carriage may be secured direct to the cylinder, or be passed from the gun to the cylinder over rollers

on the principle illustrated in Plate No. III, Figures I and II. It will be understood that by adjusting the cylinders and rollers to any given angle, the reaction of the springs will point the gun to the same angle, and thus remove the necessity of manual labor in training the guns

28. Spring power for propelling boat paddles and screws could be used with very great advantage, as two men applying their force to wind up a cylinder would propel a boat with greater speed than probably twelve men with oars, especially if the paddles were constructed to work immediately behind the stern of the boat or ship, so that the blades may strike against the current of water which continually flows towards the stern of the Ship as she progresses through the water ; thus the blades instead of striking upon water rapidly flowing from under them, would have the advantage of striking upon water flowing against them, and be able to communicate much greater propelling power. The use of spring power in propelling war vessels would also be most valuable, as these vessels when cruising could store sufficient power in springs by means of their engines as would enable them to run for 20 or 24 hours, at the rate of from 20 to 30 knots per hour, thus they could overtake any vessel they may sight, or evade a too powerful enemy. A few such Ships would be able to sweep the seas ; as the combined action of the springs and engines would be sufficient to propel the vessel with a force which would raise her in a great measure out of the water, and thus reduce the resistance attending rapid motion through this medium. It may here be mentioned that every vessel should be furnished with a buffer keel, and cut-water, extending to near the figure-head and communicating with the elastic bearings, by means of buffer rods as illustrated at Plate II, so as to protect and throw a Ship "off" (by the reaction of the springs) when she happened to run upon a sand bank, sunken rocks, or icebergs. A farther protection might be given to ships by horizontal buffers placed immediately above the water line, to protect the vessel from lateral concussion.

29. *Application to Railways.* The carriage of goods by rail is at present much more expensive than by water. Yet, naturally this should not be the case, as air presents less resistance to the movement of heavy bodies than water, and with large wheels and properly constructed axle bearings, the friction on a smooth iron rail, could be overcome by a much less force than that required for the displacement and friction of water by a load of a given weight, especially when travelling at a rate of over two miles per hour. Apparently to such an extent could this be effected, (especially when considered in combination with the high rate of speed, and with the greater convenience which land carriage affords) as to outweigh the great advantage possessed by water as a medium of transport in being insusceptible of the wear and tear attending traffic on iron, or other roads.

30. As a general rule, land carriage is most convenient, and the prosperity and wealth of every country depend in a great degree on its cheapness and efficiency. It therefore becomes a matter of grave consideration to devise the means of rendering it cheap and abundant. To form an idea of how this can best be accomplished, it becomes necessary to enquire why land carriage is at present so expensive, notwithstanding the immense amount of talent and ingenuity brought to bear on the subject. The reasons seem to be :—First—The original cost of the

locomotive engines. Second—Their rapid deterioration, with the consequent expense of maintaining them in repair. Third—The damage done to the permanent way by the concentrated weight, of the engines, and by the power being exerted in pulsations, thus causing the driving wheel to slip to a certain degree under each drag of the piston, so wearing out the rail and the wheel. Fourth—The injury to the axle boxes caused by the sinuous motion communicated to the train from the action of the pistons throwing the wheel flanges against the rail. Fifth—The original great cost of constructing the permanent way, arising from the low gradients necessary for the present means of locomotion. Sixth—The waste of motive power occasioned by the application of breaks. Seventh—The injury caused by the action of the breaks to the rails necessitating their frequent renewal near stations. Eighth—The unequal wearing of the wheels caused by their slipping along the rail when the Breaks are applied. Ninth—The injurious amount of friction, caused by the small diameter of the wheels. Tenth—The defective construction of the axle boxes for high speed. Eleventh—The inefficiency of the buffing apparatus, proving a fertile source of accidents and damage to the engine and carriages. Twelfth—Insufficient elasticity in the present modes of coupling, rendering these liable to break under a sudden jerk, and imposing on the engine at once in starting the strain of overcoming the inertia of the whole train. Thirteenth—Danger from fire.

31. These being the objections to the present mode of railway traffic, the first step to economy is to dispense with the services of the "stupendous locomotive" and substitute in its stead, a lighter, more effectual, more durable, and less expensive machine constructed to resume the force of the momemtum of the train in stopping; while its progress is maintained by a uniform roll instead of by the pulsations of the present piston. At first sight it may appear impossible to effect this, and that no machine could give the same tractive force as the locomotive in its present high state of perfection, exhibiting as it does, one of the greatest triumphs of inventive genius and mechanical art. But, when we reflect on the fact that springs will take up and retain for any length of time, the force communicated to them in winding up, it will readily be perceived that, in this way, a light, durable, cheap, and even more powerful locomotive machine than the present engine can be constructed. By "more powerful" is meant that a stationary engine can be made of greater strength than a locomotive; that a series of springs being wound up by a stationary engine will take up the whole force given by it, and as there is no limit to the number of springs which could be used, there is likewise no limit to the power which can be produced by springs. Thus supposing the springs to be contained in a cylinder revolving on a fixed axle, it will easily be perceived that a portion of the cylinder and a given number of springs could be wound up in lengths, each length being (prevented from unwinding by a powerful ratchet and) of sufficient strength to take the whole force of the engine. For instance, supposing six lengths to be wound up separately, six times the power of the engine could be obtained by the combined action of the six lengths of the cylinder, and would continue to be exerted during a period equal to that in which the engine was occupied in winding up one length. Supposing the stationary engine equal to raising 500 tons a thousand feet during the time one length of the cylinder was being wound up, the combined action of the six lengths of cylinder would raise 3,000 tons a thousand feet, less an almost inappreciable amount lost by friction. On this principle, a locomotive machine

of any required strength can be produced, of great simplicity and durability, and at a tenth of the original cost and weight of the present locomotive of like power. It has been supposed that the heavy locomotive is necessary to give 'grip' to the driving wheel. But, this seems erroneous, except when ascending steep gradients; and even if correct, this object could be better attained by loading the motive carriage with goods, and increasing the diameter of the driving wheels.

32. A system of springs, or spring cylinders, constructed and arranged as already described, and wound up by water, steam, or other power, the force thus stored in them may be communicated to propel or move Railway trains, Road carriages, and all descriptions of marine, locomotive, and stationary machinery, by the various methods and appliances at present known to mechanics for connecting carriages or machinery with the prime mover. In some instances, however, a modification of the present methods may be desirable, because a power such as that communicated by springs requires peculiar treatment, as, while it is in action, it may be said to be an unrestrained power; that is, if the force of the springs exceeds the resistance of the weight it has to overcome, it goes on increasing in speed and momentum until a rate is attained in which the resistance of the atmosphere overcomes the additional power. This, as a rule, would be a speed far too rapid to be convenient. In the construction of Horological machines, ingenious contrivances have been adopted to overcome this difficulty, such as escapement wheels, &c. But these contrivances could not be applied with advantage to Railway trains or traction machines because a uniform speed is not desirable. In fact, the machine should be so constructed as to, travel at the rate of 100 miles an hour and upwards if required, or as much under this speed as may be convenient.

33. In this machine the break L performs the office of an escapement wheel, and on the train attaining too high a speed, the action of the springs is stopped by the application of this break, and the train allowed to run on by its own momentum until the speed has decreased. In like manner, when the train is moving too slow, this break is removed and the springs brought into action for a longer or shorter period as may be required to maintain the speed. This break, however, could not be applied except the pinions F on the axle of the driving wheel had self-acting gearing, such as would run out of gear the instant they offered resistance to the direction in which the driving wheels are revolving, and as this must take place the moment the action of the springs is stopped, it is plain that without this description of gearing, these wheels would necessarily be injured by the momentum of the train.

34. This self-acting gearing is secured by means of a portion of the axle of the driving wheel which receives the pinion F forming a male screw ending in a shoulder or square projection on the axle, while the socket of the pinion forms a female screw as illustrated and described in Plate No. II, Figure VII. By this arrangement so long as the pressure is in one direction, the pinion wheels F will run home against the shoulder of the axle, and thus communicate a bearing, or driving power, in other words be as firmly fixed as if it were a portion of the axle itself. But, the instant the pressure is reversed, the pinion wheels offer no resistance whatever, as they immediately unscrew on to the smooth portion of the axle at S, Figure II, and

there remain stationary, or run in the opposite direction if necessary, while the axle revolves freely within the inner flat surface of the female screw. This difficulty being thus effectually overcome, springs offer a power more completely under our control than any other in existence, and is the only power known possessing the inestimable advantage for locomotive purposes of taking back or resuming the power it has given off.

35. When it has been considered desirable to dispense with the locomotive, and perform its work by stationary engines, applied by such means as our atmospheric Railways, traction of trains by heavy ropes, giving an enormous friction, &c., the utility of deriving a direct force stored up in springs will be at once apparent, especially when we consider that this power can be accumulated without increasing the weight of the machine, that it can be retained for any length of time, and taken off in any manner required. In addition to these advantages, when the train stops at stations, the whole force of its momentum can be re-accumulated in the springs by a simple gearing being brought into play to remove the momentum by winding them up. In like manner, the same gearing can be brought into action to wind up the springs and thereby retard the progress of the train when going down a decline. Thus not an ounce of power need be lost, as that usually destroyed by breaks would be stored up for future use, neither would there be any loss on account of the line having comparatively steep ascents and descents ; for example, a rise or fall of 1 foot in 40 or 50 feet, as by regulating the speed of a train in descending a given gradient, would so far wind up the springs as to accumulate so much power as would enable it to ascend a like gradient.

36. Plate No. II, Figures I to VIII, illustrates one principal of applying the invention to Railways. Figures I and II are a view and plan of a motive carriage propelled by a spring cylinder 8 feet in diameter, intended for the Indian guage, (but may be constructed to suit any guage). In order to show that no inconvenience either in point of comfort or appearance can arise from the use of large wheels, these are shown 10 feet in diameter, and the body of the carriage 8 feet high by 12 feet wide and 32 feet in length. A, being the portion of cylinder cut through at I and communicating motion to the two driving wheels G, by means of the wheels C D and E C, the main motive wheels on the circumference of the cylinder 8 feet in diameter and working into the pinions E, 9 inches in diameter, fixed on the axle of, and carrying the wheels D round with it, which again work into the small pinions F, also 9 inches in diameter on the axle of the driving wheels, with axle sockets working in a curved guide, so as to maintain an elastic bearing on the pinion wheels during the play of the axle springs, H framework of carriage, I ratchet, preventing the cylinder from unwinding, B cog-wheel, 8 feet in diameter, by which the springs are wound up, both by the stationary engine, and the momentum of the train by means of the wheel K, when stopping at stations, or descending gradients, &c., this wheel also communicating a reversing motion or " backing" the train when required, L break to stop the motion of the cylinder, by means of the double lever M being brought forward and hooked on to the rest N above the wheel K. This rest being placed so close above the wheel K that in coming into gear by means of the screw illustrated at Figure VII it removes the lever and throws off the break. This self-action prevents the break being brought up while this wheel is in action, which arrangement is made to prevent inattention in

the driver causing injury to the machinery. O centre bearing for axle of driving wheel, P spring for throwing the break off the wheel B, Q fly wheels, R beam for securing the springs when used without a cylinder. The spring cylinder above described is calculated to make 800 revolutions and in the act of unwinding to carry a train of 150 tons over 300 miles. If the axle bearings are provided with antifriction wheels as illustrated, the cylinder could convey more than three times this weight the above distance.

37. Figure III illustrates a passenger carriage 8 feet high, 12 wide, and 32 in length with a portion of the covering removed to show the framing. A the platform and rail supported on the buffer head and sliding with it under the cover B, so as to afford communication along the entire length of the train to both guard and passengers, C the cover for that portion of the wheels projecting above the carriage, D the break lever shown as not in use ; when applied to the wheel it is made fast to the spring E, F couplings, giving an elastic play of 12 feet between each carriage, G the antifriction wheel.

38. Figure IV is a ground-plan of the framework, showing the construction of the buffing and coupling apparatus, A cylinder or box, enclosing a series of coiled springs placed under the end seats, also in the upper ends of the carriage, and acting on a revolving axle or cylinder on which is secured three-flanged wheels, B for the reception of the chain or wire bands of the buffing and coupling apparatus. The bands of the couplings being fastened from the opposite side of the cylinder to that from which the buffers are secured, in order to cause the springs to revolve in the same direction whether the couplings are dragged outwards by the strain, or the buffers driven inwards by concussion, C spaces for the wheels.

39. Figure V, section of the carriage, cut through at the centre of the wheels, A springs for axle bearings, B the axle, C the wheels, D the seats, E covers for that portion of the wheel projecting above the carriage.

40. Figure VI is a view of the front part of a locomotive engine, showing the application of the invention to Railway buffers, A being the ends of two cylinders of coiled springs secured in a framework, and extending the entire breadth of the engine, terminating at each end in a flanged wheel for the reception of the chain or wire bands. The buffer rods pass between these flanged wheels into a square guide tube B, constructed as at Figure VIII, and fixed to the outer framework of the engine. This tube terminating in front in projecting flanges to take the bearings of the axles of the cylinders, or series of springs. The fixed buffers at stations being also constructed on the same principle.

41. It will be observed that these systems of springs would afford enormous strength, which could be increased or reduced to any desired degree by winding up the springs more or less upon the axle ; in this way the force requires to drive in the buffer rod, would be proportioned to the weight of the engine or carriage, and with sufficient play, say from 12 to 25 feet according to the size of the engine ; while the last carriage or waggon in each train, being furnished with a similar set of buffers, and each carriage in the train having proportionate elastic buffers and couplings, would give a train on accidental collision an elastic play of 12 feet

between each carriage, and from 24 to 50 feet between the engine and first carriage, this would be sufficient to remove without injury the ordinary momentum of the train. The above together with couplings giving similar elastic action would effectually remove the danger, loss of life, and destruction of material, unfortunately of too frequent occurrence at the present time. These buffers could also be so constructed, by means of a paul and ratchet to prevent them from re-acting on receiving a very heavy concussion, as their re-action would cause inconvenience by throwing the train back to a considerable distance, and although this is an unimportant subject compared with that of overcoming the danger, still it is one that should be guarded against.

42. Figure VII is a plan of self-acting gearing, or connecting and disconnecting apparatus of the wheels F and K in Figure II. A, screw for taking the wheels into gear, when the force is applied in one direction and throwing it out when the force is reversed, B shoulder or stay on the axle for the support of the wheels when brought home, C hole in the axle for the reception of the spring catch, when the motion is reversed and the train "backed," D spring catch, E section of a wheel with female screw axle socket, the face of the screw being a little larger than the circumference of the axle, in order that it may revolve freely within the smooth inner surface of the screw when out of gear.

43. Figure VIII shows the connection of the buffing rod to the springs enclosed in a cylinder, case, or framework, A being the flanged wheels for the reception of the chain or wire belt, C the chain or wire belt guide roller, D four friction rollers on the end of the buffer rod and constructed to fit the square guide tube E. The chain or wire belt is fixed to the head of the buffer rod by passing through it in a curved opening and brought up again to the top, where it is secured by means of a plate and screws as at F. This mode is adopted in order to prevent any jerk, or in other words to conduct the force of the blows on the buffer head in a direct line to the springs.

44. The foregoing remarks are specially applicable to railways. It will be observed, however, that with slight modifications the system above noticed can be applied to traffic on our common roads. The invention therefore will now be briefly considered in its application as a traction machine and for drawing or propelling vehicles of every description.

45. Figure IX is a view of a wheel with an elastic tire, for traction engines, or road carriages, so that the tire may compress and present a plane at the point of contact with the road sufficient to take the weight of the load without cutting into the ground. This is intended to remove the great inconvenience experienced from the fact of the wheels as now constructed continually presenting to the road what may be said to be the point of a wedge which must necessarily sink into the ground, more or less according to its hardness, until it has attained a plane sufficient to support the gravity of the load. This sinking of the wheel, especially in wet weather, very seriously impedes the progress of the vehicle, as it imposes the enormous friction necessary to overcome and crush down the bank of earth raised before the wheels. This ought not to be the case, as the tire of the wheel instead of crushing into the road ought

to be so elastic as to form a plane, thus removing the friction and at the same time facilitating its onward progress, by the wheel constantly springing up behind in a similar manner to the action of the foot in walking. A being the axle box, B the ring, C the spring spokes, D the manner of securing the springs to the spokes, E view of the spring and section of the tire. A non-elastic tire to take the bearing when great weight is applied, is shown by the dotted lines at F.

46. If the reduction of weight in the Railway Engine is a matter of serious consideration, how much more so is the reduction of weight in a traction engine, or such machines as have to travel on our common roads, where the great weight sinks the wheels so deep into the ground, as to offer a hitherto insuperable difficulty to applying this much desired means of turning our streets and common roads to better advantage.

47. Figure X is a view of a carriage for use on common roads, illustrating one method of propulsion by spring power. A, being the propelling cylinder constructed as already described, B the frame or bracket secured to the carriage axle for supporting the machinery, C the cog and fusee wheels, D the screw and shaft carrying round with it the beveled wheel E, working into a beveled pinion on the axle, or box of the carriage wheel, F the break, G the lever rod, H the lever which in its action applies the break and stops the driving machinery, and at the same moment brings the reversing gear or winding up apparatus into operation to impede the progress of the carriage, I the lever catches, J the guide handle.

48. Figure XI, plan of the machinery of a traction engine (when applied to single vehicles, the driving gearing on one side only is required) A being the spring cylinder, B the paul rims, C the brackets or frame, D the pinion and fusee wheels, E the screw shaft with guide bracket F, G the beveled wheel on the end of the shaft, H the beveled pinion on the axle, or axle box of the carriage wheel, constructed with self-acting gearing as described at Figure VII, I the lever rod, J the screws and guide bracket for winding up the cylinder, K cog wheel on the circumference of the cylinder, L slide socket for throwing the screw in or out of gear, M handspike holes.

49. Figure XII is the side view of the winding up apparatus, A section of the spring cylinder, B cog wheel on the circumference of the cylinder, C screw and shaft, D bracket for moving ditto on the rod E, F slide socket worked by the lever G, H socket rest secured to the flange by the gripping screw at E, I carriage axle and pinion wheel.

50. Figure XIII being a side view with the bracket or frame removed to show the arrangement of the propelling machinery, A the fusee wheel on the axle of the cylinder, B the driving chain, C the cog and fusee wheel, D endless screw and shaft, E beveled wheel on the end of the shaft, F bracket for supporting the screw and shaft moving on the frame rod G, H the carriage axle, I the break, J the break lever.

From the above description, it will be understood that this machinery may also be applied to propel or draw Railway trains, carriages, &c.

51. The use of stationary engines for winding up the springs would only be required in exceptional places; for although steam is a wonderful power, and has produced a new era in our commercial history; yet at some future day it will be looked upon as insignificant when compared with the stupendous powers which nature has placed at our disposal *free of cost, and inviting appropriation.* For example, the sun daily rises from the ocean sufficient power to drive all the machinery in the world for years, and although this power is originally generated in atoms, so infinitely small that it cannot be appropriated, yet by condensation on our mountains and plains, it is formed into rivers, which in their return to the ocean especially from high lands, could be converted into the means of propelling machinery, which could be applied to cultivate the land, harvest crops, manufacture produce, and transport goods and passengers. It is true these rivers are not always convenient to the places where the power is to be applied, but when this power can be stored in springs, it may be transported like any other commodity to the spot where it is in demand. Take the Madras line of Railway for example, and the Cauvery river would supply more power than required for the working of this line, and this power could be communicated to the springs by a water wheel, or wheels with one small pinion on the axle. Even where it is necessary to wind up the springs by a stationary engine and the expensive power generated by steam, still a great saving would be effected by this system. It is possible, however, that a means may be devised for generating steam at a comparatively small expense, as it is the fuel which forms the expensive item, and this indeed in burning does no more than give off the heat of the sun which it has taken up and stored during active vegetation. Thus fuel as a medium of storing, and giving off the heat of the sun might be at least to a certain degree dispensed with, and the sun's heat which we have here in the greatest abundance, made the direct means of generating steam with but little consumption of material. On an average we have 280 bright days in the year when the unconcentrated heat of the sun between 9 A. M. and 4 P. M., on the plains varies from 120 to 160° Fah. This heat concentrated by powerful lenses revolving by clock-work so as to be constantly in focus and thrown into concave circles or spheres in the boiler, would no doubt generate steam, the same boilers being constructed with furnaces for the consumption of fuel when used in cloudy weather or during the night.

52. The invention may also be applied to perform the ordinary work of a farm, such as carting produce, manure, digging, weeding, cultivating, &c., and where water power is available for winding up the springs, these operations could be performed at a trifling cost.

53. Figure XIV is a plan of a digging and trenching machine, which may be converted into a weeding machine by elevating the digging cylinder by the screw H, Figure XV, and into a cultivator by changing the hoes, A being the spring cylinder, B the hand-spike rim, C the cog wheel for winding the cylinder, D the travelling wheels, E the fusee driving wheel, F ditto ditto, G the fusee wheel on axle of digging cylinder, H the digging cylinder, I the hoes, J the machine handles, K the paul rim, L the guard, M the break, N the levers which as the stroke is made lift the hoes as their ends pass over the projecting bracket D, Figure XVII, the hoe being shown as thrown back at J, Figure XV, and the lever passing over the projecting bracket shown by the dotted line near the axle.

54. Figure XV is a side view of the digging machine, A the fusee driving wheel on the end of the cylinder axle, B the chain driving the travelling wheels, C chain driving the large fusee wheel, D, E chain propelling the digging cylinder, F the digging cylinder, G the framing, H the screw for raising or depressing the digging machinery, I the digging hoes, J the hoe having made the blow is shown as raised by the action of the lever O, K the break rod and handle, L the guard, M the break, N the machine handles.

55. Figure XVI is a section of the digging cylinder, A the hoes, B the axle, C the levers, D projecting bracket on the sliding box over which the ends of the levers rise as they pass, and thus lift the hoes immediately they make the stroke, E the cross rods connecting the levers, F rods fastening the handles of the hoes to the cylinder.

56. Figure XVII is the end view of the cylinder with a portion removed to show the principle of fastening the hoes, A being the spring to maintain the hoe in its position, B the lever rod, C the rod for fastening the hoes, D the projecting flanges on the axle socket in the act of raising the hoe by the action of the lever.

The above description is confined to one method only of applying the invention to purposes of cultivation, as it will be understood that spring power as a prime mover can be applied to this purpose by means of the various methods at present in use.

57. Plate No. III, Figures I to IV and VI illustrates a method of applying the invention to secure elasticity to gangways attached to Pier Heads, so that ships may be moored and secured to the gangway, and be able to ship or unship cargoes in safety in open roadsteads, or where there is a heavy swell. Figures 1 and II are a plan and section of a gangway possessing elastic motion in every direction, A portion of pier head, B head of the gangway, C the pivot giving horizontal motion, D trap doors to open when the pivot C or rail fastenings are removed or secured, E cylinders giving advancing or receding elastic motion, F the attached platform, G the sliding platform, H wire bands, belts, or chains connecting the cylinders with the cross-bar of sliding platform G, between the two rollers I, J friction rollers attached to the cross beam at the head of the sliding platform, K friction rollers fixed to the head of attached platform F, L rail friction rollers, M the guide for the sliding rails, N iron plate with spring front to keep an equal bearing on the sliding platform, O gangway head turning on a centre pivot P, with springs Q, at each side, to secure elastic motion to the heaving of the ship, R rings for fastening the gangway to the vessel, S cushion for resting the gangway on the ship to prevent chaffing, T portion of cylinders fixed on the pier for mooring the vessel, U rack rails extending from the platform to the crane A in Figure VI, V friction rollers for the rack rails.

58. Figure III, top view of the front beam of the sliding platform, A holes for cylinder bands secured as at section B, D friction rollers, C sockets for receiving the beams of the sliding platform.

59. Figure IV, section of the gangway in front of the rollers I, A the attached platform, B beam of the sliding platform, and cylinder band secured to the same at C, D friction rollers, E beams of the attached platform, F sockets for beams of sliding ditto, G planking, H rails, I guide for the sliding rails with friction rollers, J rollers for cylinder bands.

60. Figure VI, reduced view of pier and gangway, as attached to the vessel, to give an idea of its application. The gangway being drawn backward or forward by a cog wheel at the windlass A, working into the pinion or rack rail at U, Figure I. In this way it is anticipated the invention will be of great utility, as at present it is impossible for a ship to approach a pier except in still water. The gangway illustrated will overcome this difficulty and enable ships to be moored at a considerable distance from the pier head, while the vessel itself can receive no injury by heaving and pitching while attached to the gangway, as it possesses perfect elastic motion in every direction. The gangway can be constructed of any required length and breadth, the one here represented is 70 feet in length by 6 wide within the rails, giving an advancing and receding elastic motion of 15 feet in each direction, thus the platform gives an elastic play of 30 feet to the rolling, and rising, and falling of the ship; namely, it is capable of being drawn out to 85 feet, and contracted to 55 feet, 70 feet being the point at which the equilibrium is maintained by the action of the springs in the cylinder communicated to the top beam of the sliding platform by means of a chain or wire band attached to the cylinders and beam, and passing over the rollers I. The gangway is so constructed that it can be drawn off, and on to the pier by two men working the winches on each side, (one being represented at A, Figure VI, the cog wheels on these winches working into the rack rails at U, Figure I) thus carrying the gangway forwards and backwards, giving off, or taking up at the same time a proportionate length of the chain, or wire rope support attached to the outer end of the gangway, and passing to the winch over the pulley on the upright secured to the pier. The gangway when run forward to the pier head, falls into its position, its outer end being supported by a hawser, rove through a top block from the main top mast head, the pivot C is then inserted, the rack rails being at the same time unhooked from the platform through the trap doors D, Figure I, the guide chain or wire rope support from the winch may be eased when the stage is ready to be landed on the ship's gangway. This done the stage is secured to the ship by means of the rings at R and is ready for use.

61. Elastic Pier fenders are constructed on the same principle as the gangway above described. The length being reduced to 6 or 8 feet, and the breadth increased to any size convenient for a ship to lie against, or these Pier fenders may be constructed on the principle of the Railway buffers already described, being modified so as to give elastic motion in every direction, the cylinders for this purpose being placed either above or below the platform of the pier, floating harbour or breakwater.

62. The mooring of vessels prior to being attached to the elastic stage or gangway, is an essential point to be considered. With steamers this could easily be accomplished, but with sailing vessels it is an operation of considerable difficulty and hazard, arising from their movements being less under command: it is therefore necessary that this difficulty should be overcome, as no vessel could be expected to approach the moorings so long as there was danger to be apprehended. A ship perhaps could most quickly and safely approach her moorings by the aid of three floating cylinders or buoys constructed as at Figure X, the springs being secured to a framework in the interior of the buoy on the same principle as illustrated in the first Plate, Figure I, by a revolving axle, and a deep flanged wheel fixed in the centre for the reception of

the cable stoppers, the springs acting against the axle as it revolves in the interior of the buoy. The axle on each side of the wheel to pass into the interior of the buoy through a stuffing and lubricating box, in order to render the buoy perfectly air and water-tight. Two of these floating cylinders or buoys should be anchored at a distance of about 40 fathoms from the pier, and at an angle of about 45° from the centre of the pier head ; while the third and most powerful cylinder should be anchored at a distance of about 100 fathoms at a right angle with the pier head, or in a direct line seaward from the pier as in the reduced sketch at Figure IX. The mooring tackle of these cylinders would probably be most convenient if formed of wire rope, and moored to each other and to the pier head when not in use. The vessel in approaching the Pier should receive, as convenient, hawsers attached to the mooring tackle of each buoy securing to her own windlass and heaving up the tackle of that best calculated to bring her into position, while the tackle of the other two buoys should be kept tight so as to be made secure at any moment when required. The ship having thus neared her position should receive the hawsers from the pier head cylinders (partly shown at T in Figure I) and by these she could be brought exactly into position for the reception of the elastic gangway. The vessel thus secured to the gangway, it is important to her safety that she should be quickly brought out when required, by means of her own crew only, without any exterior assistance, which could not be rendered in case of bad weather coming on during the night. It will therefore be necessary prior to the workmen retiring for the night to withdraw the stage, the vessel still lying in the same position secured by the four elastic moorings. In the event of bad weather coming on the two pier moorings should be at once slipped, and the tackle of the seaward mooring from the buoy D, Figure IX, heaved up on the windlass, bringing the vessel out to sea. Thus the bows of the vessel would be brought forward towards B, and when she has reached so far, the moorings of the buoys A and C could be let go, and the ship further brought up towards D, where she could either ride out the gale, or "let go and make to sea." These remarks refer specially to the Madras Roads and to the Madras Pier in the N. E. Monsoon. When applied in other parts, the moorings would require to be modified according to circumstances, the bows of the ship when moored always lying as close to the wind as possible.

63. Figure X illustrates a floating elastic cylinder or buoy for mooring ships, A the groove of the flanged wheel, B flange of ditto, C hook for securing the cable stopper when not in use.

64. *Application of the invention to Breakwaters, Floating Harbours and Pier Heads.*— All solid buildings in the sea whether in the shape of breakwaters or piers have the disadvantage of being enormously expensive in construction ; insecure, inasmuch as they are liable to give way in heavy storms ; inconvenient, because they do not rise and fall with the tide ; and self-destroying, because they do not allow an under current of water to pass ; thus causing silting, a slow but a certain process fast rendering our finest piers unserviceable. Moreover, a pier should constantly be at a uniform level above the surface of the water, whether at high or low water, and thus at all times afford convenient access to the shipping ; it should also be durable, and at the same time constructed cheaply, and neither should a pier or a breakwater

impede the flow of water for more than 8 or 9 feet under the surface, as the agitation is on the surface of the water only, therefore impeding the under current only causes silting without producing any equivalent benefit. It is for the above reasons that floating piers, and harbours or breakwaters, with elastic moorings offer great advantages over anything hitherto attempted. Those accustomed to the terrific effects of the sea will conceive that the floating harbour illustrated at Figure V would be dashed to pieces by the first storm, but the immense benefits afforded by an elastic anchorage is not yet understood, as in fact this elastic anchorage enables us to combat the sea with its own weapons, as the sea destroys by an accumulated force suddenly exerted upon an inflexible body, and this anchorage enables us to overcome its power by exactly the same means, namely, by an accumulating and receding resistance. This will practically and more effectually overcome the force of the sea than we can at present conceive, because as the floating piers, harbours or breakwaters recede, they rise at the same time over the waves, and the violence of the sea will be deprived of all its fearful effects. These breakwaters and piers especially such as have to stand in open roadsteads, should be constructed to give motion at short distances, 10 or 15 feet along their entire length, so as to rise and fall with the waves. This motion would be secured by connecting the beams by two iron shoulders fastened by a powerful loop joint, and embracing the ends of the beams as at C, Figure VII. The loop joint would give motion in every direction and be less liable to wear than any other form.

65. Figure V is a view of a floating harbour and pier combined, A being a fixed pile-pier, extending beyond the surf. This pier and the floating harbour being connected by two elastic gangways at C, while D are the elastic cylinders for mooring the harbour, E being a line of low store houses or shops with the roof sloping to seaward down to the level of the framing of the harbour, F elastic fenders for ships to lie against when shipping or unshipping cargoes, G elastic draw-bridges at the entrance of the harbour.

66. Figures VII and VIII being a plan and section of the barges and framework of floating piers, harbours or breakwaters, A represents the barges, B the framework, D mooring cylinder, C the manner of connecting the beams by an iron loop joint and shoulders to allow of play in every direction, E the water-line, F section of a barge.

67. *Application of the invention as a stationary power.*—From what has preceded it will be apparent, that the invention can be applied to drive all descriptions of machinery, especially such as is required to perform detailed and tedious operations not requiring very great force; for example spinning and weaving, moving punkahs, bread-making, sewing, churning, winnowing, grinding and washing. In working this machinery the springs would of course only give back the force they received in winding up, still, the advantages would be great, as this force could be extended over a great length of time, and be made to perform the most tedious labor, with far greater effect than if performed by the hand. Another advantage exists in the springs being placed in the most favorable position to receive the full force of manual exertion, as by the lever or handspike, both the muscular force and the weight of the body is brought into play at the same instant to wind them up; for example the cylinder being used in working the pumps on boardship, a man could convey to the springs in one hour, as much force as would

throw from the hold of the ship the same quantity of water as he could have raised by six hours manual exertion at the pumps, because pumping by hand is a muscular exertion, and when the muscles are kept long in action, great fatigue necessarily follows, while the winding up of the cylinder is an exertion in which the muscles play but a small part compared with that of the weight of the body, in applying which no fatigue is sustained; but on the contrary, a rest or relief. Hence it is that a man under the one condition, can perform six or even twelve times the quantity of work that he could under the other.

68. An irregular motion may be given to punkahs by the arrangement illustrated in Plate No. II, Figure XVIII, which shows the principle of fastening the punkah rod to the slide A, fitting a square box, revolving on a projecting pin attached to one of the wheel spokes; the slide being securely fixed at any given elevation to the box by the screw B, on a projecting pin, passing through an axle-box fitting the slide A. By elevating or depressing this slide a greater or less variation in the motion of the punkah is obtained, and consequently a greater or less current of air as may be required.

69. The wheels of the machines illustrated and described above are constructed on the principle of the fusee of a watch, in order to compensate for the less power of the springs as they unwind, or to communicate a greater or less force to the driving wheels as required. The chains can be removed from the greater to the smaller diameter of the wheels, or *vice versâ*, by the ordinary forked lever. The fusee principle is here noticed as being best understood, but a more convenient arrangement and one which would as effectually compensate for the reduced power (and give the driver the advantage of being able to place such extra power on the driving wheels, as would overcome any accidental difficulty) could be procured by the nave and spokes of the wheel, being formed in one piece, and the felloes made in eight or any convenient number of segments. Each segment to have at least two hollow sockets, for the reception of the spokes, these sockets being furnished with perforations for one or two spring catches to pass through on the principle of the paul and ratchet, and fit into corresponding depressions in the spokes. By these means the circumference of the wheels can be enlarged or contracted at pleasure by moving in succession, the segments as they turned from under the pressure of the chains. The bearing of the lever for this purpose being placed on the side of the wheel clear of the action of the chains, and constructed to expand the one wheel, and at the same time to contract the other in proportion. It will be understood that the expansion and contraction of the wheels would not in any way affect the action of the chains; because as the one wheel is contracted the other will at the same moment be expanded in exact proportion.

70. As a Dynamometer, and weighing machine, the invention possesses special advantages from the fact of the springs being enclosed in an air-tight cylinder, and thus effectually protected against the influence of the atmosphere, while the springs being of great length in proportion to their thickness, every condition requisite in such machines is thus present. Hence the machine could be so adjusted as to register force, or weight, with the greatest accuracy, and to maintain its action unvaried for any length of time. This invention could also be used with advantage in throwing projectiles, especially for harpoons, as the sudden explosive force of gunpowder is unsuited for this purpose, being apt to break the line. Also for couplings to steam tugs; as a means of storing power in cranes; and as a motive power in mining operations, excavations, &c.

SUMMARY.

71. The idea of connecting Ship cables to an elastic bearing attached to the vessel, having occupied the attention of the author for upwards of 17 years, the elastic windlass, capstan, or cable stopper, is submitted with great confidence in its practical efficiency to secure the objects required. It possesses in the highest degree all the qualities necessary for the security of shipping while at anchor, namely :—1st—Perfect elasticity of the cable bearing. 2d—Instantaneous action to the force of the waves :—3d—Great elastic play extending from 600 to 900 feet and upwards. 4th—The elastic force may be increased to any desired degree, by winding up the springs more or less against the cable stopper, by the handspike wheel and pinions A, and B in Plate No. I, Figure VII. For example a cylinder giving 90 revolutions, its force against the cable, or cable stoppers can be increased as 90 to 1; because the force of the springs increases or decreases in this ratio, with every revolution in winding up or unwinding. 5th—the springs being enclosed in a cylinder excluding the external air and thus preserved against rust, consequently may last for centuries. 6th—It places the Ship under immediate control, enabling her position to be changed with facility, either by the cable being heaved up on the cylinder, or released.

72. A Ship anchored by the elastic cylinder would ride with the following advantages :—1st—She would never receive a blow from the seas, because as the base of each wave touches her bows, she begins to recede, and at the same time to rise over the wave; and when the force of the wave passes, she will return to her former position. The Ship will thus ride easily under the heaviest storms; and will rise with ease and without concussion over the heaviest seas. 2nd—The anchors will not drag or the cables give way, as it is the concussion Ships now receive which drags the anchors and parts their cables :—3d—the ship not being subjected to concussion while at anchor will be more durable. 4th—It secures ships against drifting on lee shores, as when this danger is apprehended an anchor can be dropped; and the vessel brought to and ride out the gale in any position with far greater safety than if maintained at sea under sail. 5th—The anchor can be raised and instantly brought to the bows with less than half the number of hands now required.

73. *Railway trains, &c.*—The application of the invention to Railway trains either as an auxiliary to the Locomotive, or as the sole motive power, would effect a reduction of about two-thirds the present cost of Railway traffic; inasmuch as the spring cylinder could be made the means of resuming the power at present lost in stopping at stations, and storing the force of gravitation in going down gradients, and to give off this power in aid of the Locomotive in starting and ascending gradients. Thus the spring cylinder in resuming the power would act as a break, and as the wheels would continue to revolve it would avoid the present wear and tear of rails and wheels, in short it would dispense with one of the greatest expenses in Railway management, namely, employing a costly power to give motion to the train, and a still more expensive power in the shape ot breaks to destroy that motion. This moreover is the only principle whereby the natural power of the elements, (wind or water) can be made to store itself by winding up spring cylinders, and the force thus stored could be preserved and applied in any manner, and at any time required. This fact opens up a path which may lead to results of inconceivable magnitude.

The elasticity given to the buffing and coupling apparatus of Railway carriages and Locomotive engines, would remove a most fertile source of accidents, and afford perfect communication along the whole length of the train to both guard and passengers; moreover the elastic force of the buffing and coupling apparatus could be increased to any desired degree by more or less winding up the springs, and thus adjusted to buff engines or carriages of any given weight and at any given speed with a certainty of preventing serious damage from concussion. The anti-friction wheels for the axle of the Railway carriages also offer additional advantage in continually presenting a cool surface to the axle. The other alterations suggested in our present system of Railway management appear correct in principle although no doubt defective in detail, being in fact brought forward more as suggesting what ought to be accomplished, than detailing correctly the manner in which it is to be accomplished. Although the benefits of elasticity are well understood, it is a principle which may be said to be altogether neglected in practice, and this is very extraordinary, as there is not an Engineer, or Mechanic, but perfectly understands that elasticity is indispensable to the duration, and safety, of every moving body, whether animate or inanimate.

74. *Application to Road Carriages.*—This offers perhaps one of the most extensive fields in which the invention can be employed; especially in a country like this, where the conveyance of produce to the sea coast is so uncertain, that crops frequently lie an entire season after harvest before they can be removed. It would also be most useful in performing the ordinary work of a farm, such as carting produce, manure, digging, weeding, &c., and where water power is available for winding up the springs, these operations could be performed at a very trifling cost.

75. *Ship and Fort Armour.*—This subject is perhaps the most difficult and complex that has come under consideration, from the fact that iron and steel as a protection to Ships is very defective; but the training of the guns by means of the elastic cylinder, the self-acting port-holes discharging the guns by electricity, and the construction of ball proof walls by beams placed in a longitudinal direction to the line of the shot, are believed, each to posses advantages which probably may be realized in practice.

76. *Breakwater, Floating Harbours and Pier Heads.*—For the extension of pier heads, and the formation of floating piers, the advantages of the invention are apparent as also for the formation of floating breakwaters to shelter or enclose the mouth of harbours. When experience has established the advantages of an elastic anchorage in a heavy sea way, probably floating harbours and piers combined, similar to those illustrated in Plate III may be constructed and applied with safety.

77. *Elastic Gangways and Pier Fenders.*—The application of the invention to those purposes will permit vessels to lie against an elastic support and roadway to the quay or pier when shipping or unshipping their cargoes.

◆

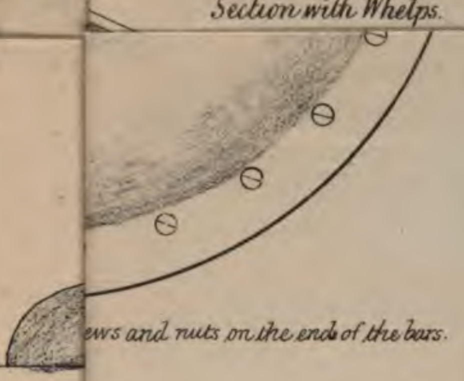
N. B.—THOMAS SHORT, Junior, 41, Great Charles Street, Birmingham, is authorized to receive orders for the manufacture and supply of the Apparatus above described.

P CABLES &CA

No. I

FIG. II.

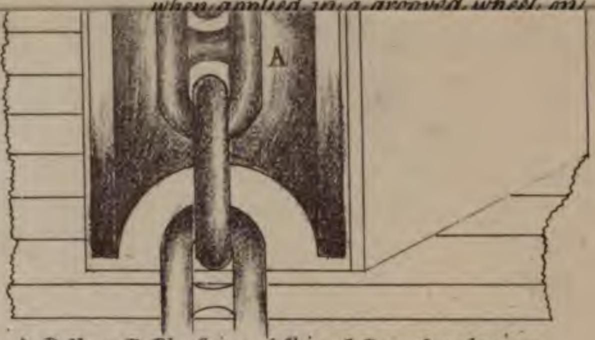
Section with Whelps.



ews and nuts on the ends of the bars.

FIG. III.

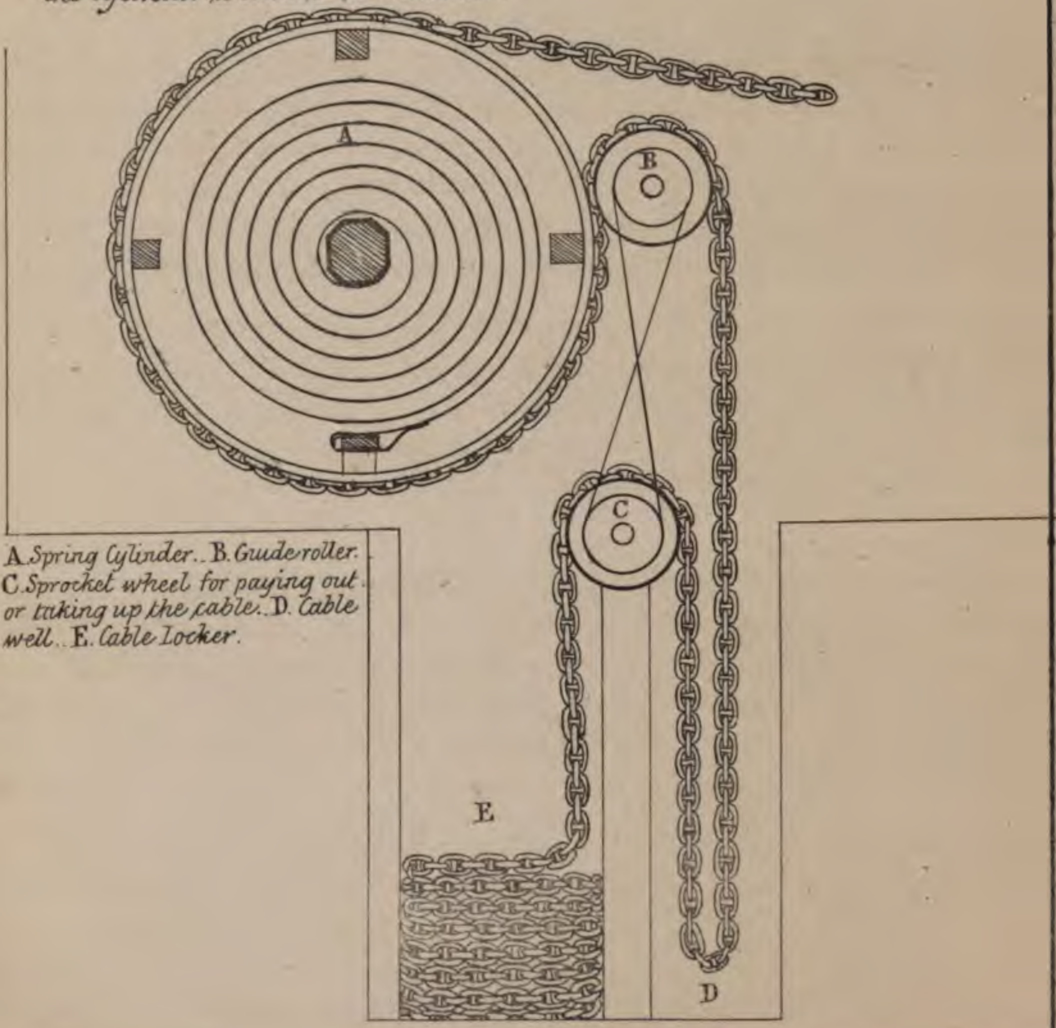
Section shewing the fitting of the Cable
when applied in a grooved wheel,



A. Rollers. B. Planking of Ship. C. Door for closing Hawse holes when not in use.

FIG. XII

Sectional sketch illustrating the working of the Cable when the Cylinder is used as a Windlass.



A. Spring Cylinder. B. Guide roller. C. Sprocket wheel for paying out or taking up the cable. D. Cable well. E. Cable Locker.

Sketch

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RACTION MACHINES &c.

N°.

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I. C
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A, *fusee driving*
wheels. C, *ditto: ditto: large*
cylinder. G, *frame.* H, *screw*
Fig. X*oes.* J, *one hoe having made the*
drivin break rod and handle. L, *guard.*
M, *bre*

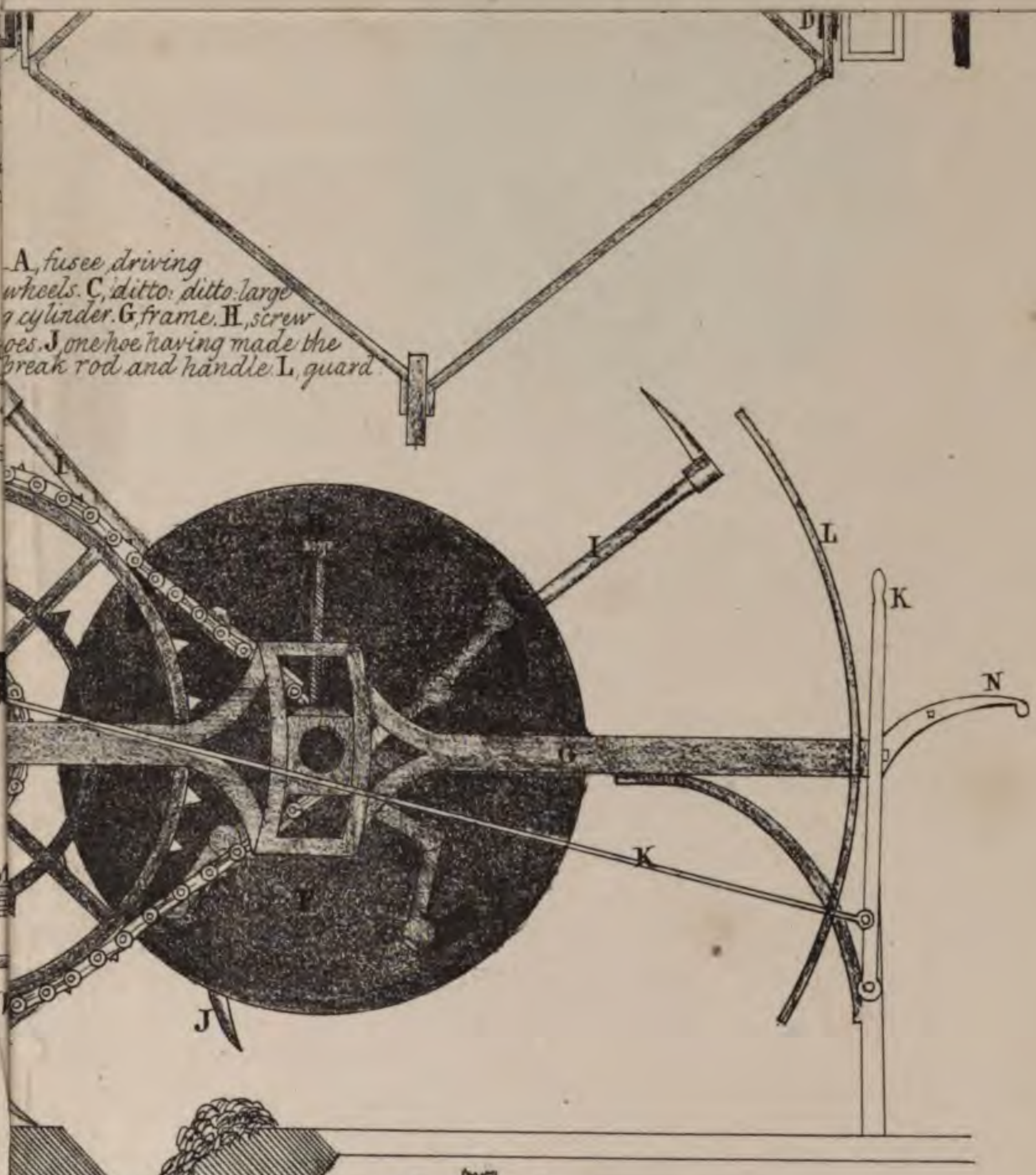

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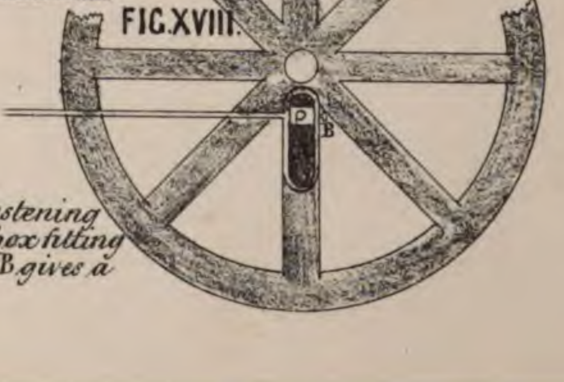
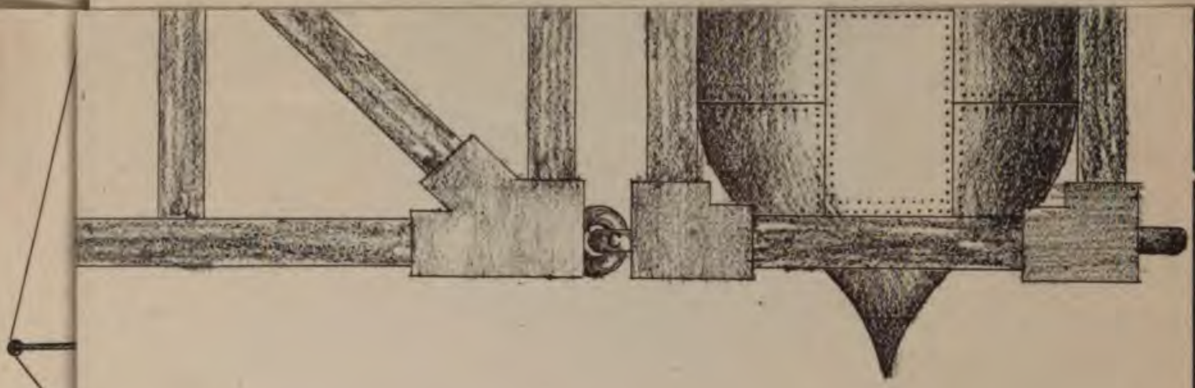
FIG. XVIII.



Batc

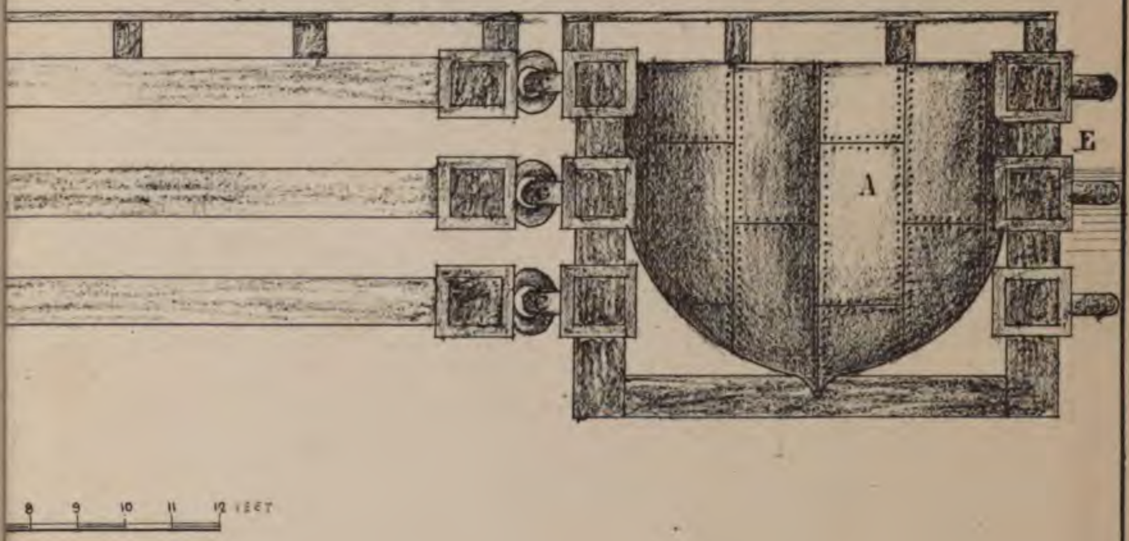
APFERS, FLOATING HARBOURS OR PIERS &CA

Nº III



ointed as at C, between each barge to allow of play
ine shewing the position of the anchoring cylinder.

FIG. VI.



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